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of the methods which have culminated, as I conceive, in that which is presented for adoption in the preceding pages. I have sought to do so impartially, and to the best of my information and ability; and I hope it will not be found that in what I have written I have afforded cause for complaint to the friends of any of the gentlemen whose claims I have had to discuss.

It only remains now that I should mention, that in Captain (now Major-General) Shortrede's *Logarithmic Tables** (1849), all the methods I have exemplified (with the exception of Mr. Manning's) are illustrated; and one and two-figure tables, of both Weddle's and Hearn's forms, are given for their application—the two-figure tables extending to 16 places and the one-figure to 25.

On Government Annuity and Assurance Rates and Regulations.
By MARCUS N. ADLER, M.A., of the *Alliance Assurance Office, Fellow of the Institute of Actuaries and of the Statistical Society.*

[Read before the Institute, the 24th April, 1865.]

IN briefly commenting upon the papers that have been presented to Parliament on the subject of life assurances and annuities now granted by Government, it is less my object to criticize the measures that have been adopted, than to explain the mode of construction of the several tables of rates that are being acted upon. In consequence of several assumptions and suppositions, these have not been computed in the mode usually adopted by actuaries.

I may remind the members, that last year, when the Bill which has now passed into law was before Parliament, I had the honour of reading a paper before the Institute on this subject, and it is a source of satisfaction to me, that most of the suggestions contained in that paper appear to have been adopted. I feel particularly gratified that an Act was passed towards the end of the last Session, the 27 & 28 Vict., cap. 56, by which Probates or Letters of Administration for amounts not exceeding one hundred pounds, are

* Will it be considered out of place if I here call the attention of computers to this very useful work? In a handy volume it contains, besides sundry smaller tables, the ordinary seven-figure logarithmic table, and also an anti-logarithmic table of like extent. The convenience of the latter table, when many numbers to logarithms of seven places have to be taken out, is hardly conceivable by those who have not made trial of it. It is a great advantage also to have both tables in a single volume. The price of the book is, I believe, only twelve shillings.

exempt from stamp duty,—a boon which will be much appreciated by the working classes.

The table of mortality, the rate of interest, the loading in the case of premiums payable more than once a year, and the whole mode in which the tables are presented, are precisely those I ventured to suggest last year; and no doubt the members will share my opinion, that in the case of surrender of policies the authorities are acting prudently in not undertaking to return the whole or half the premium, as was originally proposed, but an amount depending upon the duration of the policy, the age at entry, and other elements. I shall have occasion to revert to the question of surrenders, but I may here at once express the hope, that the publication of the tables for surrender values will not be deferred. Although policies may not actually attain a value until they have been five years in force—that is, not before the year 1870 at the earliest—still, as it is intended to publish the tables of surrender values, it would be well if it were done at once, so that intending assurers may know exactly what bargain they enter into with Government.

To proceed to the consideration of the tables themselves.

As regards annuities—the old Government tables, founded on Mr. Finlaison's observations made, in the year 1823, upon the males and females of the tontines and sinking fund, are made use of; in fact, the very tables are adopted which have hitherto been acted upon at the National Debt Office—the rate of interest being $3\frac{1}{4}$ per cent.* The premiums for assurances are based upon the third English life table, lately published by Dr. Farr, the rate of interest being taken at 3 per cent. Comparing the two tables, we should find that if the third English life table were adopted throughout, the rates for annuities would be somewhat higher than they are at present, and such proceeding would be justified by the well-known longevity of annuitants. True, the rates now charged are based upon the mortality experienced by that very class of annuitants; but we know that the value of life is increasing, and besides the fact of allowing $3\frac{1}{4}$ per cent. interest, instead of 3 per cent., is a sufficient advantage in itself to annuitants. But more: the tables for the grant of deferred annuities and deferred monthly allowances (page 26 and 27 of the tables), which have been calculated on purpose to go hand in hand with the insurance rates, have a loading of 10 per cent. upon the net rates. The pure premiums for assurances are loaded 20 per cent. Now, it may be questioned

* It may be interesting to know that the rates granted under 3 Wm. IV., cap. 14, were computed at $3\frac{3}{4}$ per cent., and that no distinction was then made between the sexes.

whether such an arrangement is equitable. In the case of annuities, the trouble which the loading is intended to cover, is about as great again as in the case of assurances. For not only has the Office to *collect* the premiums in small instalments, but it has to *pay* the money away in small weekly or monthly stipends, whereas in assurance transactions, the amount contracted for is, in all cases, paid away in one sum.

The tables for the granting of Government life annuities were constructed on the assumption that the annuities were payable half-yearly, the first payment becoming due on the second quarterly day of payment next following the date of purchase. It is found by experience, that the public, in order to have the utmost benefit for their money, purchase these annuities but a few days before the respective quarter days, receiving the first payment of the annuity but a little after a quarter of a year's interval. The interest, as in the case of the dividends upon the public funds, is considered convertible half-yearly, so that half-yearly life tables had to be constructed, in the manner sketched out at page 334 in Griffith Davies' *Treatise on Annuities*, and analogous to those given by Dr. Farr in his recent work.

Of this fact Mr. J. W. Stephenson, the writer of a letter in the last Number of the *Assurance Magazine*, does not appear to be aware; and yet it must be admitted that this procedure is most conformable to practice, as, in the majority of cases, both interest and annuities are payable half-yearly. The formula deduced by Mr. Stephenson for the single premium of a deferred annuity, with the condition that the premiums paid are to be returnable on death or on application, at any time prior to the commencement of the annuity, is only partially correct, for the option of the withdrawal of the premium does not appear to have been duly taken into account. Mr. Stephenson assumes that the interest of the single or annual premium is to be applied year by year during the term to the purchase of an annuity deferred n years. The computations for Government were made upon a different supposition. The Act 16 & 17 Vict., cap. 45, sec. 4, provides, that deferred life annuities may be granted on condition that the purchase-money shall be returnable, but without interest. Acting in accordance with this law, the Government premiums for annuities, "money returnable," were computed by a mode which does not appear to have been known hitherto outside the doors of the National Debt Office, thus:—In the case of an annuity to a person now aged x years, such annuity to commence

n years hence, the single premium for an immediate annuity to a life aged $x+n$ years discounted for n years was taken as the single premium, and this amount divided by the present value of £1 per annum for n years, the first payment due immediately, gave the annual premium.

It is not for me to justify a course that was duly approved of and has been acted upon for so many years—for, be it remembered, that these annuities were granted also under 3 Wm. 1V., cap. 14, and surely the author of the tables would know the full import and bearings of the words of the Act, in the drawing up of which he was doubtlessly consulted. If interest were taken into account in the manner pointed out by Mr. Stephenson, the National Debt Office would give the full benefit of interest at $3\frac{1}{4}$ per cent. to those who deposit money under the form of an annuity, whereas interest to Friendly Societies is now only allowed at the rate of 3 per cent., and to depositors with Post Office Savings Banks at little more than $2\frac{1}{2}$ per cent., an arrangement which would clearly be less equitable than that adopted by Government.

Mr. Stephenson further draws attention to the fact that, according to the Government tables the value of life at age 31 is greater than that at age 21; and similarly, that the value of an annuity for 10 years is precisely the same at the ages of 21 and 39. It was hardly necessary to deduce these apparent anomalies from a comparison of the tables of immediate and deferred annuities; a mere glance at Observation 20, page 58, of Mr. John Finlaison's Report on the Law of Mortality of the Government Life Annuitants, would suffice to enable one to notice there a like phenomenon. The mortality per cent. of the males of the Tontines and Sinking Fund, at age 13, is .52586; from this point it increases to age 24, at which the mortality is 1.41539; then it diminishes up to age 34, at which it is 1.24006, and it is only about the age of 48 that the same probability of death is exhibited as at age 24.

In the words of Sir John Lubbock,* "observations such as those exhibited by Mr. Finlaison, where the deaths are given at every age, are particularly well calculated to determine delicate points, such as any small increase of the rate of mortality at different ages."

But the experience table of the Government male annuitants is far from being the only table presenting this peculiarity. Similar aberrations are found to exist in Dr. Heym's experience table of

* *Transactions of the Cambridge Philosophical Society.*

the males of the Berlin Widows' Fund;* in De Montferrand's table of mortality of males in France;† in Quetelet's tables founded on the statistical returns of Belgium,‡ &c.

Professor Buchanan has also alluded to this subject in a paper read before the British Association in the year 1855. He quotes Quetelet as ascribing the inordinate mortality at age 23 and 24 to the violence of the passions at that age. The same results occur among females, although obscured by the increased mortality among them at a later age, from dangers peculiar to the sex.

The peculiarity adverted to did not even escape Dr. Price, nearly a century ago. In speaking of the Northampton Tables, he says,§ "The Bills give the numbers dying annually between 20 and 30 greater than between 30 and 40; but this being a circumstance which does not exist in any other register of mortality, and undoubtedly owing to some accidental and local causes, the decrements were made equal between 22 and 40; preserving, however, the total of deaths between 20 and 40 the same that the Bills gave them."

Here we plainly see one of the disadvantages of graduating a table of mortality in too sweeping and arbitrary a manner; it will always be found a proceeding calculated to efface any peculiarities exhibited by the original observations.

From the examples above adduced, I trust I have succeeded in showing that the circumstance alluded to *does* exist in other tables of mortality, and being exhibited not only in English but in foreign tables also, it can be ascribed neither to accidental nor to local causes.

It seems then to be abundantly proved that the mortality does not increase from age to age; and so far from being startled at Mr. Stephenson's discovery in connexion with the Government annuity tables, we may well be surprised at that gentleman not having been acquainted with so noteworthy a circumstance, upon which I only fear I have dwelt at too great a length. I now pass to the consideration of the rates for assurance.

In the statement accompanying the tables it is remarked, that, as far as practicable, the addition to the net premium for costs and charges was made proportional to the work that was to be done in return for it. Generally speaking, the loading is charged not only for the trouble of collecting the premiums and for Office expenses, but

* *Rundschan der Versicherungen*, jahrgang iv., p. 291.

† *Journal de l'Ecole Royale Polytechnique*, tom xvi., p. 306.

‡ *Bulletin de la Commission Centrale*, vol. v.

§ *Observations on Reversionary Payments*, 5th edition, vol. i., p. 352.

also to cover the risk of fluctuation. This latter seems to be altogether ignored in the tables; but, on the other hand, by 27 & 28 Vict., cap. 46, s. 3, provision is made, that if from the quinquennial valuation it shall appear, that the amount of liabilities is greater than that of the assets, the deficiency shall be made good from the Consolidated Fund. But if it shall appear that the value of the assets is more than sufficient to discharge the liabilities, an amount, not exceeding four-fifths of the surplus, shall be applied to the cancelling of the securities held by the Commissioners for the Reduction of the National Debt.* Nothing is said about the remaining one-fifth, but it may be presumed that it is intended to serve as a kind of reserve fund.

It follows, at all events, that the loading is only meant to cover charges and expenses, and under those circumstances it appears to be rather unfairly levied. In cases where the premium is paid more than once a year, be it half-yearly, quarterly, monthly, or weekly, there is an equal loading—20 per cent.; but in the case of the premiums payable yearly, the loading is but 10 per cent. Now, this cannot but be regarded as an injustice to that large class of intending assurers, to whom it would be more convenient to pay the premiums half-yearly or quarterly than yearly. How many are there who have to await the payment of their half-yearly dividends, small though they be, or of their quarterly salaries, before they are in a position to pay their premiums? Now, why should these people be charged nearly 13 per cent. more than those who pay their premiums yearly, and be placed upon the same footing with those from whom the premiums have to be collected monthly or weekly? The exact addition for the chance of death and loss of interest in the case of half-yearly premiums is under $2\frac{1}{2}$ per cent. Even taking the most unfavourable view—viz., that adopted by Dr. Farr—which I shall have occasion to allude to further on, the addition does not exceed 3 per cent. No respectable Assurance Company would charge much more than this. As the matter at present stands with regard to the Government rates for assurance, the difference between the yearly and half-yearly premiums range from 4s. to £1 for every £100 assured.

In the construction of the tables the assumption has been made throughout, that the amount assured is not payable at the end of the year in which the assured dies, but at the instant of death. I

* According to the wording of the Act, at the end of every five years a valuation of the engagements made and liabilities incurred during the preceding five years is to be prepared. Surely it cannot be intended to ignore all the transactions entered into prior to the five years preceding the valuation.

will not stop to inquire whether $\sqrt{1+i}$ or $1 + \frac{i}{2}$ should be the proper multiplier to transform the present value of a sum payable at the end of the year of death into that payable at the instant of death. Perhaps it may be recollected, that this point was fully discussed in the pages of the *Assurance Magazine* some years ago. No one will however dispute that, theoretically, the exact value for an assurance payable at the instant of death is that given by Bailly—viz., $\frac{i}{\log_e(1+i)} A_x$, where A_x is the present value of a reversion payable at the end of the year of death. Expanding this expression, we have $\left(1 + \frac{i}{2} - \frac{i^2}{12} + \dots\right) A_x$, or $\left(1 + \frac{i}{2}\right) A_x$ nearly, which has been adopted by Dr. Farr.

Tables 1 and 2, showing what single premium or consideration money, in one sum, must be paid in any year to assure the payment of a certain sum at death, have been calculated on this assumption, that is, the value of the reversion payable at the end of the year of death, at 3 per cent., has been multiplied by 1.015. This net premium was then loaded by 2 per cent., and a further addition of 2s. to the single premiums made, in all cases of insurances for sums under £50.

It may be asked who will be willing to pay the Government a sum of money as a single premium, when by investing it in Consols, or in some other security, and applying the interest towards the payment of the yearly or half-yearly premium of an insurance, a person can secure the same, and even greater benefits, without at all parting with his capital? For instance, a person aged 20 years next birthday, instead of paying to the Government Assurance Office the sum of £37. 0s. 2d., as a single premium for an assurance of £100, would do much better to take therefrom £1. 4s., as the first annual premium for an assurance of £66, and invest the balance in Consols. The dividend accruing from this investment would suffice to keep the insurance on foot. Whilst retaining nearly £36 during his lifetime, a person would at his death bequeath to his heirs the sum of £102—viz., £36 invested, together with £66, the amount assured.

True, if arrangements were made by which the assured under Tables 1 and 2 could receive back the amount paid by him, whenever he wishes to surrender the policy, the rates proposed would not be found too high; but no such terms appear to have yet been offered. Surely then the condition that no policy or contract

for assurance will have attained a surrender value until it has been 5 years in force, that is, not until the year 1870, ought not to hold in these cases. Considerations for the surrender of single premium policies should be given at any time, even immediately after the completion of the contract.

Table 3, showing the annual premium that must be paid for an assurance for the whole of life, is at once deduced from the table of the net annual premiums given in page 52 of Dr. Farr's work, by multiplication by 1.015 and an addition of 10 per cent.

Table 4, showing what sum payable at death may be assured by the payment of an annual premium of £1, is merely the reciprocal of the values in Table 3.

We now pass to the tables showing the amount assured when the premiums are paid more than once a year. Here the assumption is made that the premiums are paid "continuously," by which is meant that the year is considered to be divided into a number of small intervals, and a proportional part of the payment is made at each of these intervals. It is also assumed that the numbers living through the year are represented by the numbers living in the middle of the year, that the deaths are equally distributed over the year, and that the average time of the investment of the premiums received, may be set down at half a year, as the deposits are equally made throughout the year.

On these assumptions Dr. Farr gives, in the Appendix to the 12th Report of the Registrar-General, the different formulæ, and deduces that π'_x , the annual premium for an assurance at the death of a person now aged x years, $= \frac{M'_x}{Q'_x}$,

$$\text{where } M'_x = \left(1 + \frac{i}{2}\right) M_x,$$

$$\text{and } Q'_x = P'_x + P'_{x+1} + \dots = \left(1 + \frac{i}{2}\right) (l_{x+\frac{1}{2}}v^{x+1} + l_{x+1\frac{1}{2}}v^{x+2} + \dots).$$

Both M'_x and Q'_x , which latter resembles the ordinary N_x of the commutation tables, are tabulated at page cl. of the Preface to the English Life Tables.

Similarly, where only a limited number of premiums are paid, such as is assumed in Tables 6 and 7, the formula is $\frac{M'_x}{Q'_x - Q'_{x+n}}$.

I have before remarked on the heavy addition in respect of premiums payable more than once a year. A person, however, who can manage to pay a somewhat high amount in the first instance, viz., one whole year's premium, can evade all this extra

expense, without giving any the less trouble to the Post Office authorities. Anyone can open an account with the Post Office Savings Bank by paying into it, weekly or monthly, his small savings—be they as low as 1s. At the end of each year he can direct, by virtue of § 33 of the Government Insurance Regulations, that the requisite amount of annual premium should be placed to the credit of his life assurance account. A depositor would thereby not only save the increased rate of premium, but realize besides the usual interest of 6*d.* per £1 on his investment with the Post Office Savings Bank.

The Government propose to exclude persons following the occupations of miners, butchers, innkeepers, sailors or mariners from the benefit of life assurance at the ordinary terms. It may be presumed that these occupations are so singled out, because in the 14th Report of the Registrar-General, persons following these occupations exhibit the greatest mortality. It must be regretted that such scanty information is afforded on this head in the different Reports of the Registrar-General, but there is little doubt that under the able administration of that department the results of the last census will be made available for this interesting inquiry.

The following table exhibits the mortality of sundry occupations given in the 14th Report of the Registrar-General, as compared with that deduced by Mr. Henry Ratcliffe.

Comparative Annual Mortality per Cent. according to Occupations.

Ages.	DR. FARR'S OBSERVATIONS IN 1851.			MR. RATCLIFFE'S OBSERVATIONS ON FRIENDLY SOCIETIES, 1850.				
	English Males.	Publicans.	Miners.	Miners.	Clerks.	Printers.	Potters.	Total Experience of Manchester Unity.
25-35	·948	1·383	·849	·899	1·065	·646	1·267	·830
35-45	1·236	2·045	1·135	1·221	1·289	1·244	1·655	1·053
45-55	1·787	2·834	2·015	2·313	4·377	4·046	2·697	1·753
55-65	3·031	3·897	3·450	3·966	5·514	6·172	3·790	3·531
65-75	6·396	8·151	8·051	8·334	7·799	7·038	6·384	6·623
75-85	14·055	18·084	17·867	11·406	12·686	11·007	10·719	12·584

The discrepancies between the two investigations are, no doubt, great in some cases; but we must recollect that Dr. Farr gives the mortality of all who compose a certain class, whereas Mr. Radcliffe gives only the mortality of such of those classes who may have joined Friendly Societies. Most of Mr. Radcliffe's results are fully borne out by Mr. Neison's observations, given in his work on *Vital Statistics*.

It will be seen that the rate of mortality of clerks, printers, and potters is almost throughout higher than that of miners; and whereas one-half of the whole of the persons forming Mr. Radcliffe's experience entering at age 18 die off before attaining 63½ years, one-half of the class of clerks entering at 18 die off before attaining age 54, one-half of the class of printers before age 56, and potters before age 57, whereas one-half of the number of miners die off only at 60. Cutlers, plumbers, coopers, stonemasons, &c., also exhibit a more unfavourable mortality than miners.

On the other hand, the class of butchers, agreeably with the investigations of Messrs. Radcliffe and Neison contrasts rather favourably with the mortality of other trades; and this view is confirmed in various Reports of Dr. Letheby on the sanitary condition of the city of London. Without stopping to pursue this inquiry further, I will only add that Dr. Thomson,* Dr. Ward,† and the author of an article in the *Quarterly Review* for January, 1860, seem also to dissent in some measure from the views propounded in the 14th Registrar-General's Report.

Again, we know that in certain localities and towns in the United Kingdom the mortality is much above the average. Dr. Letheby considers that a mortality of 15 in the 1,000 is that which is natural in this country, whereas the rate in the *city of London* is 30 in the 1,000, or as high again. The accompanying table exhibits the mortality in various localities in this country as deduced from several tables.

Comparative Annual Mortality per Cent. according to Locality.

Age.	English Life Table, No. 3. Dr. Farr.	Healthy English Districts. Dr. Farr.	Scotland. Neison.	Glasgow. Ratcliffe.	FRIENDLY SOCIETIES' EXPERIENCE.				Age.
					Finlaison.	Neison.			
						Rural.	Towns.	Cities.	
20	·846	·728	·701	·852	·74	·739	·535	·645	20
30	1·038	·856	·793	1·769	·77	·711	·740	·928	30
40	1·295	·963	1·077	2·535	1·03	·797	·960	1·401	40
50	1·768	1·232	1·583	3·600	1·50	1·200	1·627	1·940	50
60	3·116	2·228	2·910	8·013	2·61	2·160	3·273	3·046	60
70	6·104	5·239	5·095	5·044	7·228	6·392	70

If an extra rate be charged in respect of those who follow hazardous occupations, why should not a similar additional charge

* "On the Influence of Occupation on Health and Life;" a paper read by Dr. E. H. Thompson, at the Social Science Congress for 1862.

† "On the Medical Estimate for Life Assurance;" by Dr. H. Ward. (*Assurance Magazine*, vol. viii.)

be made in respect of those who are unlucky enough to live in unhealthy districts?

One other matter I wish to refer to before I conclude. Although I have from the beginning given my cordial support to the measure which has now passed into law, I did so feeling persuaded that the respectable Assurance Companies had no cause to fear Government competition. My presumptions in this respect have been so far borne out. The premiums charged by Government are higher than the non-participating rates of most of the respectable Assurance Companies. The latter also offer that great advantage to the assured, that in the event of his engaging at any future time in certain hazardous trades he is not liable to an extra payment. Assurance Companies will, perhaps, in the long run be the gainers, for Government is in fact advertising for them, and an employer who recommends his servant to assure, can certainly not do less than assure his own life, only for a larger amount, and in order to do this he must necessarily apply to the Assurance Company.

I also supported the measure in the hope that by the extension of assurance in its most attractive and popular form, it would be largely made use of by the working classes, and thus confer a lasting benefit upon the country at large. Now, it is a mistake to suppose that the facilities in the modes of payment, or that the security the Government offers, will prove so attractive to working men as to induce them to abandon their clubs and friendly societies and to rush to assure with Government.

How was it with respect to annuities? Perhaps it is not generally known, that by the 3rd William IV., cap. 14, similar facilities, as are now offered by the new Act, were then granted. The consideration money in respect of annuities, immediate, deferred or temporary, could either be paid by weekly, monthly, quarterly, or yearly instalments, as suited the convenience of the purchaser. Yet so few availed themselves of this privilege, that the Act was repealed after having been 20 years in force.

As the case now stands with regard to assurances, I think the labouring men of this country will show a similar aversion to entering into contracts with Government direct, not because they are not provident—perhaps they are more provident than any other class of society—but because they are unwilling to sever their connexion with the clubs to which they are so attached. It may, under these circumstances, be worth considering that the present minimum of £20 for assurances be reduced, and that in the same manner as the General Post Office, agreeably with § 32 of the Regulations, is

empowered to make arrangements with superior officers and employers for collecting the premiums amongst those employed by them, so it should constitute all savings banks, but especially Friendly Societies, its agents.

No risk whatever would be incurred by Government, for the friendly societies would have to account weekly or monthly for the monies received, and the assured might be supplied with their receipts for the premiums paid direct from the Head Office. In this manner the greatest opponents to the Government scheme would become its warmest supporters, and our legislators, instead of administering a death blow to those ancient institutions, that are so entirely in harmony with the spirit of the nation, would preserve and render them a lasting service by freeing them of their greatest element of insecurity. I venture to think that by this step, more than by any other, the benevolent intentions of the promoters of the Government Assurance Bill will be most successfully realized.

On the Rates of Mortality and Marriage amongst Europeans in India. By SAMUEL BROWN, F.S.S.

[Read before the British Association, Section (F), at Bath, September, 1864.]

IN a paper which I had the honour of reading before the Institute of Actuaries in December, 1862, an inquiry was made into the rates of mortality and marriage amongst Europeans in India, but was principally confined to the experience amongst military officers, as recorded in the books of the Madras Military Fund, and compared with the records of similar funds in the other Presidencies. The data—which I was favoured with an opportunity of collecting during an elaborate investigation into the position and prospects of the fund—extended over the long period of fifty years, from 1808 to 1857, and related to more than 5,000 officers who had entered the fund in that period, and had either died, or withdrawn, or were living at the close of the observations, on the 1st January, 1858. The subdivision of the facts into two periods, of those who entered from 1808 to 1822, and from 1822 to 1857, showed a very marked diminution at every quinquennial period of age in the rate of mortality up to the age of 50, after which, in the latter period, the numbers were not sufficient fairly to carry on the comparison. On the average of all ages the rate in the former period was 3·92 per cent., and in the latter 2·69